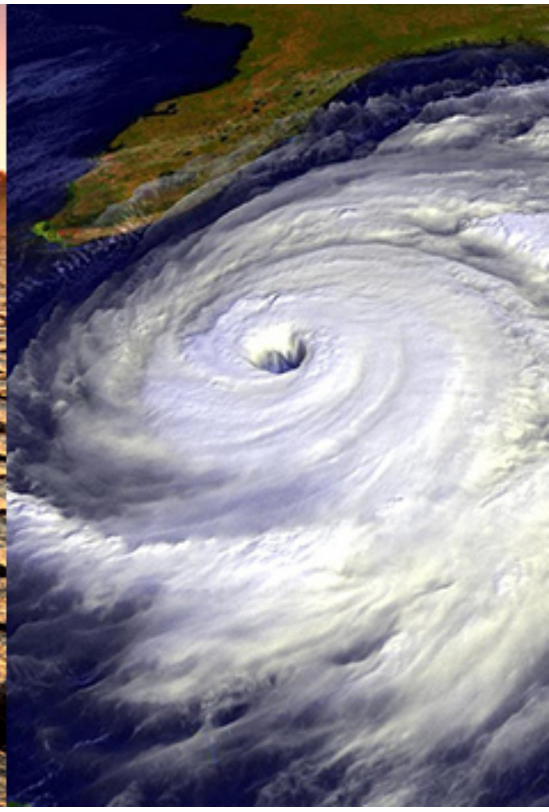
Planning for Campus-Community Resilience to Climate Change in Champaign-Urbana





ISEE

DEPARTMENT OF URBAN + REGIONAL PLANNING

Second Nature

Planning for Campus-Community Resilience to Climate Change in Champaign-Urbana

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Chapter 01

Background

Human induced climate changes have been having detrimental impacts on the environment of the earth and the whole natural system for decades. Efforts to reduce the impact of climate change are two prong- mitigation of the impacts and resilience to impacts. Building resilience to climate change impact is a relatively contemporary endeavor, compared to the ongoing mitigation efforts globally. This report has been commissioned by the Institute for Sustainability, Energy, and the Environment (ISEE) at the University of Illinois at Urbana-Champaign (UIUC) to conduct research on activities undertaken and methods employed by campuses (including signatories of Second Nature's resilient commitment) and other organizations to address adaptation to climate change. There is no definitive roadmap, as mentioned by the Second Nature[1], for achieving this goal. Hence a detailed analysis of methods which are being employed nationwide by academic and profession organization is a vital starting point.

Global efforts have been underway to reduce the impact of human activity on the climate, with mixed successes. These efforts focused mainly on 'mitigation' strategies with a focus to reduce or prevent emission of greenhouse gases (GHGs)[2]. But mitigation efforts are focused on long term reduction of GHGs which might take decades to have an observable impact, if applied properly, which is a great challenge itself. One of the many stakeholders at the forefront of these efforts are the colleges and universities in the USA. In late 2006, a group of twelve colleges and universities presidents initiated a network named the American College & University Presidents' Climate Commitment (ACUPCC). This network along with the non-profit Second Nature, ecoAmerica and the Association for the Advancement of Sustainability in Higher Education (AASHE), created "commitments" and started campaigning to all their peers to sign and implement the commitments[3]. In 2008, University of Illinois at Urbana-Champaign (UIUC)

[1] Second Nature. (2017). *Overview of Resilience.* Climate Resilience. Avaiabel at http://secondnature.org/climate-guidance/sustainability-planning-and-climate-action-guide/building-blocks-for-sustainability-planning-and-climate-action/climate-resilience/
[2] UN Environment. (2017). *Low-Emission Growth: Promoting Renewables and Improving Energy Efficiency.* Available at http://www.unep.org/climatechange/mitigation
[3] Second Nature. (n.d.). *Background*. Available at http://secondnature.org/who-we-are/background/

became one of the hundreds of signatories of the Carbon Commitment devised by ACUPCC, to become carbon neutral by 2050[4]. As a part of the commitment it developed Illinois Climate Action Plan (iCAP) which was updated in 2015.

The concept of resilience has become one of the important topics in the discussion in recent years, with increased experience of disruptive effects of climate change all over the world. Climate resilience has been described as the "[a]bility to survive disruption and to anticipate, adapt, and flourish in the face of change"[5]. ACUPCC and Second Nature have developed "resilience commitment" which UIUC signed in 2016, which warrants analysis of vulnerabilities of the campus infrastructure, landscape, natural resources and energy production, due to the impact of changing climate. This assessment will in turn assist to develop the iCAP in future years, to address those vulnerabilities.

These two goals complement each other. While the carbon neutrality commitment paves the way to reduce the impact of the campus on the climate, the vulnerability assessment required by the resilience commitment will prepare the campus to address the impact of changing climate. Thus, these two commitments create an action plan addressing both climate change 'adaptation/resilience' and 'mitigation' strategies. Figure 1.1 depicts this relationship.

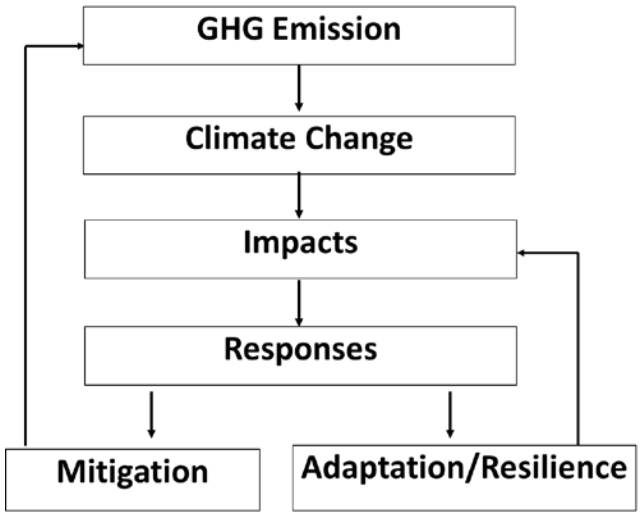

Figure 1.1: Climate Change response strategies, modified from McCarthy, et. al. (2001)[6]

[4] ISEE. (2015). *Illinois Climate Action Plan (2015 iCAP).* Available at http://sustainability.illinois.edu/campus-sustainability/icap/
[5] Boscio, G. (2017). *What is Climate Resilience?* Second Nature. Available at http://secondnature.org/wp-content/uploads/ClimateResilienceHandout-Nov2015.pdf
[6] McCarthy, J. J., et. al. (2001). *Climate Change 2001: Impacts, Adaptation, and Vulnerability.* Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change Published for the Intergovernmental Panel on Climate Change. Cambridge University Press, UK.

The primary goal of the resilience commitment is to develop an action plan to increase resilience[7]. The commitment sets specific deadlines for several objectives with yearly progress reviewing and reporting system. One of the principle objectives to achieve the goal is to conduct an initial campus-community resilient assessment including initial indicators and current vulnerabilities[8]. Following diagrams summarizes these commitments designed by the ACUPCC and Second Nature:

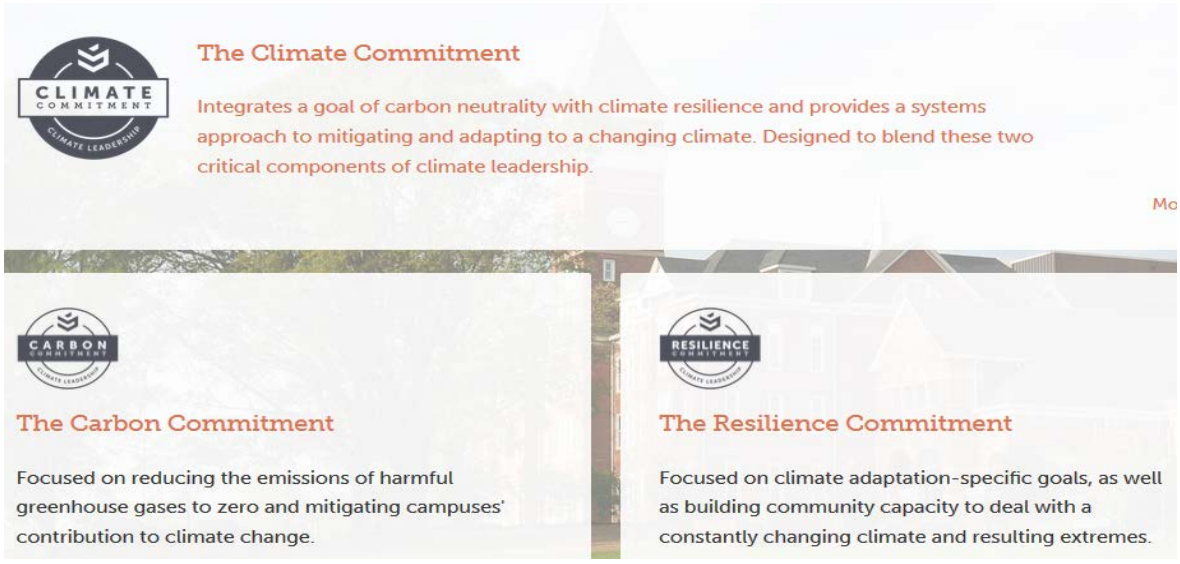

Figure 1.2: Commitments to Second Nature from signatories[9]

Structure of this report:

This literature study involves a two-prong analysis. The first part (Chapter 2) will involve review of literature, reports, websites of organizations who are involved in sustainability and resilience planning. Following section (Chapter 3) will also involve a review of scholarly literature involving climate action planning and resilience planning.

Next step toward creation of a Climate Resilience Plan is to take an inventory of efforts made by the Champaign-Urbana community which UIUC is a part of. This includes gathering information about the local impacts created or forecast to be, by the changing climate. Chapter 4 of this

[7] Second Nature. (2016). *Climate Leadership Statement.* Available at http://secondnature.org/wp-content/uploads/2015/09/Resilience-Commitment-Second-Nature.pdf
[8] ibid
[9] Second Nature. (2016). *The Presidents' Climate Leadership Commitments.* Available at http://secondnature.org/what-we-do/climate-leadership/

report describes activities undertaken by the campus- community to increase resilience against climatic disruptions. Based on the literature study and the state-of-affairs of Champaign-Urbana, next section (chapter 5), describes future steps which can be taken by ISEE to achieve the objectives set by the Second Nature's resilience commitment.

Chapter 2

Efforts to increase resilience in campuses in the USA:

It has not been long since climate resilience became an issue that is actively addressed through research and planning on university campuses. Since its creation, 99 colleges and universities have signed the Climate commitment (Climate commitment is the combination of Carbon and Resilience commitment) and 2 colleges signed only the resilience commitment devised by the Second Nature. All these 57 campuses have been trying to understand and propose what can be done in this regard.

Campuses which have signed the carbon commitment, have a functioning Climate Action Plan (CAP) with focus on GHG emission reduction, carbon neutrality and sustainability. Many have already attempted and created some plans focusing resilience, some even without aiming at increasing resilience. But these efforts are sporadic and aimed at specific objectives (eg. emergency response) rather than aiming at increasing overall resilience. Different institution aimed at different objectives based on local needs.

After thorough review of available documents from the 101 institutions which have signed the resilience commitment, resilience related efforts have been categorized into following four types and this section describes example from each category:

1) Focus on bio-diversity
2) Emergency response protocol and plan
3) Education and research
4) Outreach and coordination with other agencies and community

2.1) Increasing bio-diversity:

A number of institutions focus on increasing bio-diversity as a means to increase climate resilience. UIC is one of the 99 Climate commitment signatories. After signing the resilience commitment, the Chancellor's Committee on Sustainability and Energy (CCSE) at UIC updated the 2009 Climate Action Plan and set forth new goals focusing on – i) carbon neutrality, ii) zero

waste campus, iii) net zero water campus and iv) biodiversity[10].

While first three goals focus on sustainability and mitigation, goal four aims to create a resilient campus through creating a landscape which will be very supportive to variety of flora and fauna. One of the major goals in this regard is to promote increased consumption of locally produced food. In short term, UIC campus has set several action items. To promote local produce, campus proposes to host a farmers' market and bring local produce to campus community. Campus also proposes to utilize the greenhouse infrastructure inside the campus to produce food and increase contracting local vendors for food supplies for the campus[11].

Another short-term action item set to achieve the goal of increased bio-diversity is to enhance the tree canopy and diversity. These action items set goals not to plant trees from the campus inventory exceeding 5% of same species and 10% of same genus to increase diversity. Increasing tree canopy coverage to 25% by 2030 is another objective with increased use of sustainable landscaping methods[12].

2.2) Emergency response plan:

Perhaps one of the most common strategies to increase resilience is to build up a robust emergency response plan. Even institutions without robust sustainability or resilience try to create a natural/man-made disaster/emergency response plan. University of Oregon is an example of such attempt. University of Oregon is also one of the Climate Commitment signatories and in the process of vulnerability assessment and following steps required by Second Nature. But to cope with possible disaster scenarios (natural/man made) they have produced an elaborate emergency response plan[13]. Major parts of this plan are emergency management structure (policy group, agency administrators, incident command system organization, incident management team, command and general staff etc.), emergency operations, transfer of command, incident action plan, deactivation process and recovery.

[10] UIC. (2016). *UIC Climate Commitment Overview.* Available at https://sustainability.uic.edu/files/2016/04/UIC-Climate-Commitments-Overview.pdf
[11] ibid
[12] ibid
[13] University of Oregon. (2017). *Emergency Action Plan.* Emergency Management and Continuity. Available at https://safety.uoregon.edu/sites/safety1.uoregon.edu/files/uo_emergency_operations_plan_2017.pdf

Following diagram shows an example of the elaborate setup proposed in case of an emergency:

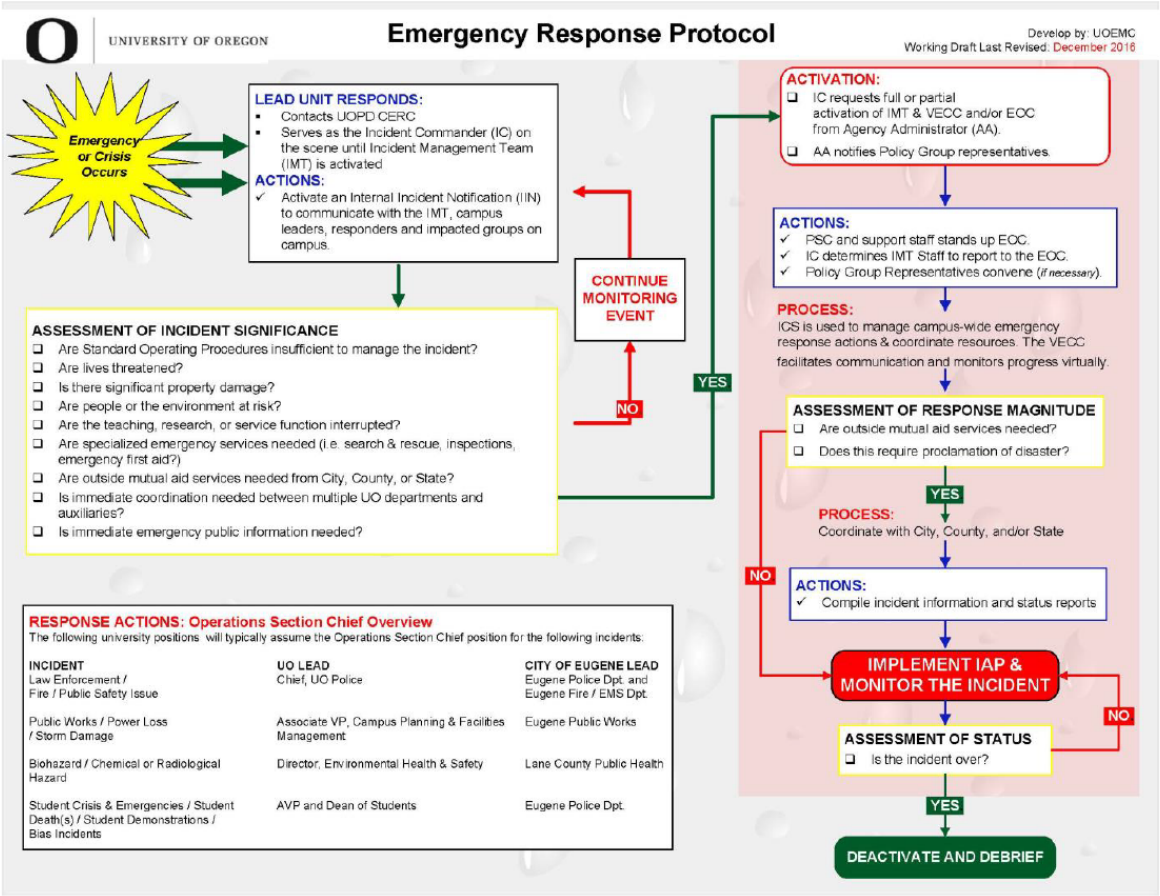

Figure 2.1: Emergency response protocol developed by University of Oregon

2.3) Education and research:

Many institutions have focused on research and education on climate change issues since long. There are numerous examples of dedicated institutions created by many colleges and universities to conduct research. Though these institutes were created mainly focusing sustainability and mitigation, gradually their efforts extended to resilience and adaptation issues as well. There are also numerous examples of undergraduate/graduate level courses and degrees in climate change issues. One of the best examples of this is the Masters in Design Studies with a focus on Risk and resilience, offered by the Harvard University Graduate School of Design.

Center of Resilience at Ohio State University is another example of institution dedicated for research purpose. This institution conducts researches on resilience based on the interest of the sponsors and disseminate the results and tools widely. Their clients include corporations and government agencies which also sponsors confidential researches. Though this center is not directly involved in the campus resilience plan effort, it has the capacity of directly contribute to that efforts through developing tools, methods and research.

2.4) Outreach and cooperation:

One of the many purposes such institutes serve is to create a community level co-operation among various stakeholders. For example, the Climate Readiness Institute, created by the University of Berkeley, brings together academics and professionals from government, private sector and no-profits to work together to inform climate decision making policies in the Bay Area through research and projects[14].

Another prominent example is the Cornell University Cooperative Extension and Agricultural Experiment Stations which provides climate adaptation support to farmers across the state. The Institute for Climate Change and Agriculture serves as a focal point to facilitate research, education, and outreach to reduce the agricultural sector's collective impact on the climate and to help farmers become more resilient to climate change[15].

In summary, education institutions in the US have been working on adaptation strategies since early 2000s, but resilience planning efforts are comparatively recent. Most of the efforts in resilience planning have been focused to increase bio-diversity, emergency action planning, education/research and outreach activities. The signatories of resilience commitment of the Second Nature are attempting to create a more organized framework for resilience planning. Continued discussions are happening to achieve the first objective of the commitment: conducting a resilience assessment of the campus-community. But not much progress has been made in this regard.

[14] CRI. (2016). *Our Method.* Available at http://climatereadinessinstitute.org/#mission-and-method
[15] Cornell University. (2013). *2013 Climate Action Plan Update & Roadmap 2014-2015.* Available at http://csc-production.s3.amazonaws.com/2014/04/15/02/46/38/230/CAPUpdate2013Roadmap2014_2015.pdf

Chapter 3

Literature review:

The purpose of this chapter is to conduct a review of available literature on resilience/vulnerability assessment methodologies and resilience planning framework. There is a vast pool of research materials to draw from on this front. Climate resilience has been gaining increased importance in the literature about cities and climate change[16,17,18, 19] . Extreme weather events like Hurricane Katrina (2005) and super storm Sandy (2012), paved the path for the USA government to increase concentration in building resilience and preparedness[20, 21, 22]. Major works have been done focusing the extreme weather events in coastal areas[23]. Multi-criteria Decision Analysis (MCDA) and scenario analysis have been employed to effectively to engage different stakeholders in the resilience planning process[24 , 25, 26]. Most of these research focus on policy implication and discussion on general importance of resilience and preparedness to survive through extreme weather events and rebuilding strategies. The focus of this chapter was kept primarily on finding literature that discuss on structured and generic framework for developing a resilience plan for a community/city/region. Also, an extensive review was conducted to find suitable resilience/vulnerability assessment methods.

[16] Pelling, M. (2003). *The Vulnerability of Cities: Natural Disasters and Social Resilience*. Earthscan. London, UK.
[17] Boyd, E., Osbahr, H., Ericksen, P., Tompkins, E,. Lemos, M., Miller, F. (2008). *Resilience and 'climatizing' development: examples and policy implications*. Development, 51:390-396.
[18] Sperling, F., Valdivia, C., Quiroz, R., Valdivia, R., Angulo, L., Seimon, A., Noble, I. (2008). *Transitioning to Climate Resilient Development Perspectives from Communities in Peru.* Environment Department Papers, Climate Change Series. World Bank. Paper Number 115. Available at http://siteresources.worldbank.org/INTCC/Resources/WB-EDP-115-Transitioning-to-Climate-Resilient-Development-Peru.pdf
[19] Economics of Climate Adaptation Working Group. (2009). *Shaping Climate Resilient Development: A Framework for Decision-making*. Available at http://ccsl.iccip.net/climate_resilient.pdf
[20] IPET. (2009). *Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System*. Available at https://biotech.law.lsu.edu/katrina/ipet/Volume%20I%20FINAL%2023Jun09%20mh.pdf
[21] The White House. (2012). *Improving Performance of Federal Permitting and Review of Infrastructure Projects.* Executive Order 13604 of March 22, 2012. Available at https://www.gpo.gov/fdsys/granule/CFR-2013-title3-vol1/CFR-2013-title3-vol1-eo13604
[22] The White House. (2013). *Preparing the United States for the Impacts of Climate Change.* Executive Order 13653 of November 1, 2013. Available at https://www.gpo.gov/fdsys/pkg/CFR-2014-title3-vol1/pdf/CFR-2014-title3-vol1-eo13653.pdf
[23] USACE. (2015). *North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk, Final Report to Congress*. Available at http://www.nad.usace.army.mil/Portals/40/docs/NACCS/NACCS_main_report.pdf
[24] Linkov, I., Moberg, E. (2012). *Multi-Criteria Decision Analysis: Environmental Applications and Case Studies*. Boca Raton, FL: CRC Press. ISBN: 9781439853191.
[25] Karvetski, C.W., Lambert, J.H., Keisler, J.M., Sexauer, B., Linkov, I. (2011). *Climate change scenarios: Risk and impact analysis for Alaska coastal infrastructure*. International Journal of Risk Assessment and Management, 2011; 15(2–3):258–274.
[26] Tourki, Y., Keisler, J., Linkov, I. (2013). *Scenario analysis: A review of methods and applications for engineering and environmental systems*. Environment Systems & Decisions, 2013; 33(1):3–20.

3.1) Resilience Planning Framework:

There has been considerable amount of research conducted over the last decade on developing a planning framework for building resilience. Most of these are discussed in a general theoretical point of view and focused at city level. Developing a framework for building resilience for campus communities can be a unique challenge, which is currently in the process of research and development. In order to building a framework for UIUC, it is a good starting point to gather the knowledge already generated on resilience planning framework. Following section discusses five approaches to build a planning framework for building climate resilience.

3.1.1. The Climate Resilience Framework (CRF), ISET-International:

One of the most comprehensive framework has been proposed by the Institute for Social and Environmental Transition-International (ISET-International)[27] and applied to the resilience planning efforts of ten cities across Asia through the Asian Cities Climate Change Resilience Network (ACCCRN)[28]. The framework is showed in the following diagram:

[27] ISAT-International. (2012). *Overview.* Climate Resilience Framework. Available at: http://i-s-e-t.org/projects/crf.html
[28] Tyler, S., Moench, M. (2012). *A framework for urban climate resilience.* Climate and development. Vol. 4, No. 4, pp. 311–326. DOI: 10.1080/17565529.2012.745389

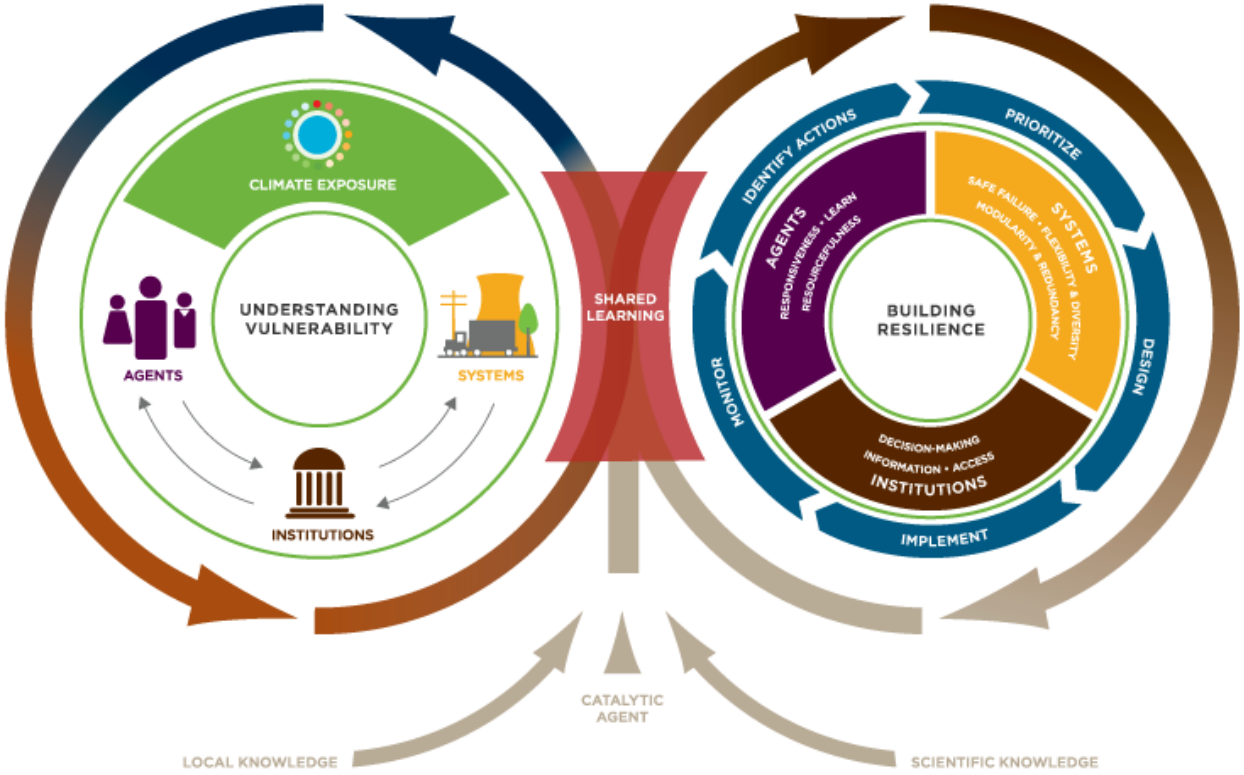

Figure 3.1: The Climate Resilience Framework (CRF) developed by ISAT-International (2012)[12].

This framework proposes resilience planning should be an interactive, analytical and a systems-based approach. The goal is to create a "networked resilience" where agents work in constant feedback loop. Local knowledge, agents and stakeholders and scientific knowledge creates a shared learning environment which then facilitates understanding the local level resilience status (or vulnerability). Then through an interactive action plan among agents, systems and institutions, resilience is built. The interaction happens in five steps which works in a feedback loop- 1) identifying actions/vulnerabilities, 2) prioritizing vulnerabilities, 3) designing to address the vulnerabilities, 4) Implementing the design, and 5) Monitoring.

Though this framework has not been applied to a campus community scale yet, it showed promising results when applied at the city level. During the application of the framework in ten Asian Cities through ACCCRN, it was found that local practitioners were able to grasp the framework with ease and could apply the iterative process of the framework. The shared learning process became an important element of the resilience planning process of those

cities[29]. This is one of the important features of the model that can be very beneficial while applying to a campus level which involves stakeholders from various level of understanding and technical knowledge.

3.1.2 Coastal Storm Risk Management Framework, USACE:

United States Army Corps of Engineers (USACE) has developed a framework focusing the storm risk management in the areas along the North Atlantic coast[30]. Figure 3.2 shows the framework:

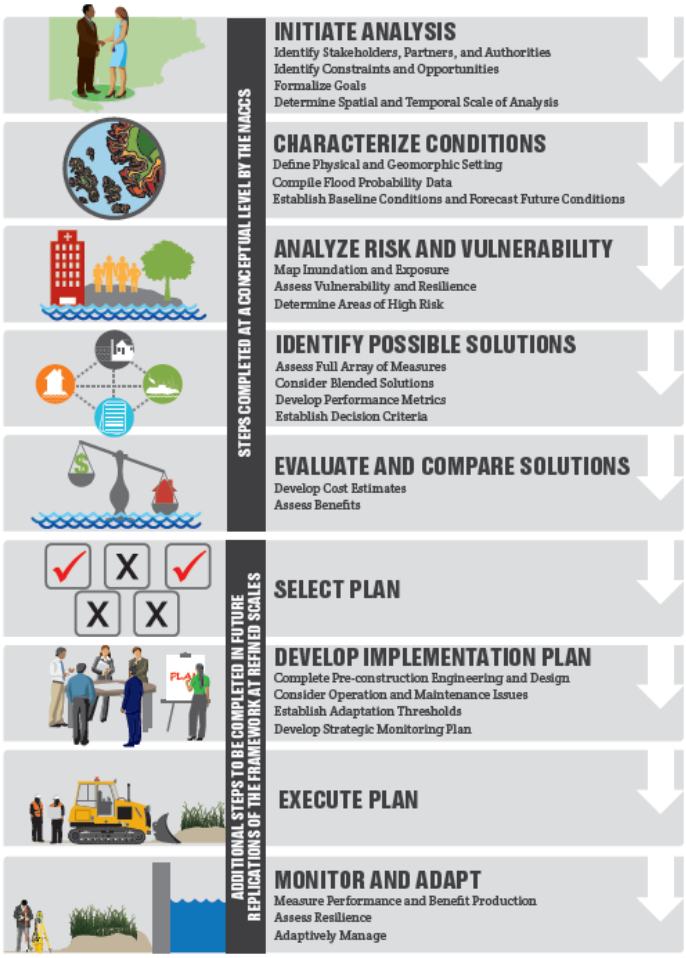

Figure 3.2: Coastal Storm Risk Management Framework, NAACS

This framework employs a similar strategy to the CRF (3.1.1). A major difference is in the mechanism of engagement of stakeholders. While the CRF focused strongly on engaging the

[29] ibid

[30] USACE. (2015). *North Atlantic Comprehensive Study: Resilient Adaptation to Increasing Risk.* Main Report. Available at http://www.nad.usace.army.mil/Portals/40/docs/NACCS/NACCS_main_report.pdf

stakeholders in all the steps of the process, this framework proposes a top-down approach. This framework is also unique in its execution method. Steps 1-5 shown in Figure 3.2, are proposed to be executed at three different scales consecutively- national, regional (State and large watershed) and local (and small watershed). Other than in Step 1, consecutive steps are conducted by the research team. This framework is expected to have a better applicability in diverse regions due to its application in three different scales, though it has been applied only is the North Atlantic coastal region[31].

3.1.3. City Resilience Framework, the Rockefeller foundation/ARUP:

The City Resilience Framework has been developed by ARUP with support from Rockefeller foundation[32]. This framework has been recommended by the 100 Resilient Cities (100RC)[33] to its member cities who seek the organization's assistance for building resilience. The framework is shown in Figure 3.3.

Figure 3.3: City resilience framework, the Rockefeller Foundation/ARUP

[31] ibid
[32] The Rockefeller foundation, ARUP. (2015). *City Resilience Framework.* Available at https://assets.rockefellerfoundation.org/app/uploads/20140410162455/City-Resilience-Framework-2015.pdf
[33] http://www.100resilientcities.org/about-us/

This framework takes a systems approach to resilience. According to the framework, every system of a city should have seven qualities (Flexible, Redundant, Robust, Resourceful, Reflective, Inclusive and Integrated). Increasing or ensuring these qualities of the systems make the city more resilient, not just to natural shocks, but also to many other stresses which contribute to the weakening of the strength of system in a longer term. It defines the systems of a city in four categories (most outer ring in grey in Figure 3.3) and twelve goals (Yellow band in figure 3.3). This framework addresses the complexity of a city and the strong interconnectedness of numerous factors when it comes to resilience to climate change impacts.

It is difficult to anticipate the effectiveness of the framework in a campus settings in absence of empirical evidence, but this framework offers a range of benefits to offer its potential suitability. ARUP has considered a wide number of factors which are important in defining the resilience of a particular community and to offer critical guidance to create a 'robust' and 'holistic' decision making process[34]. This versatility makes it an ideal candidate.

3.1.4 Climate adaptation planning framework, Cornell Climate Action Plan:

Perhaps the most related framework for the purpose of UIUC's objective, is the climate adaptation planning framework created by the Cornell University[35]. Formulating a 'Climate Adaptation Plan' is one of the goals of the Climate Action Plan (CAP). The framework was proposed as a precursor to that end. Figure 3.4 shows the framework:

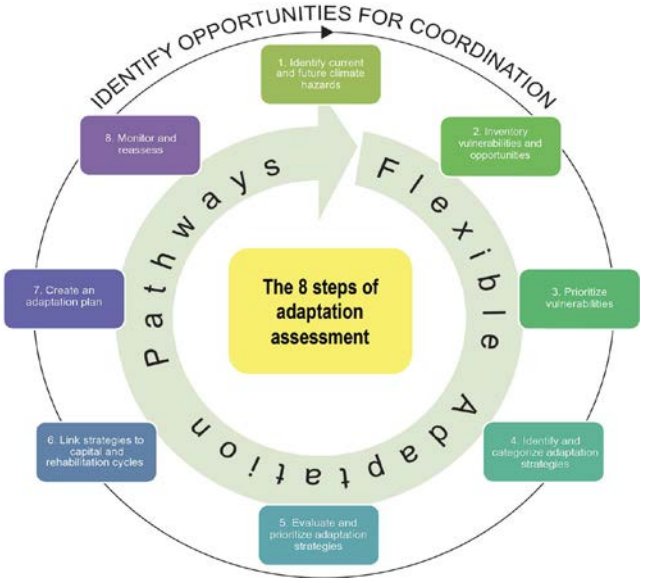

Figure 3.4: Climate Adaptation Planning Framework, Cornell University (2016)[19]

[34] ARUP. (2014). *City Resilience Index Research Report Volume 3 Urban Measurement Report*. London: ARUP International Development and the Rockefeller Foundation. Available at http://www.cityresilienceindex.org/wp-content/uploads/2016/05/Vol3-Urban-Measurement-Report.pdf

[35] Cornell University. (2016). *Climate Adaptation Planning.* Sustainable Campus Initiative. Available at: http://www.sustainablecampus.cornell.edu/initiatives/climate-adaptation-planning

This framework takes a step by step by framework which paves a path to prepare a functioning climate adaptation/resilience plan. The cyclic process starts with identification of future climate hazards and understanding the status of the community in terms of vulnerabilities and opportunities. After prioritizing the actions from this understanding, possible adaptation strategies should be identified and evaluated. Next step is to create the adaptation plan. Lastly the framework creates a feedback loop through monitoring and reassessing the plan periodically. As a campus community collaboration, this framework can be a suitable example for UIUC to formulate its own climate resilience plan.

3.2 Resilience/vulnerability assessment:

The most immediate reporting requirement of the resilience commitment to the Second Nature is to conduct a resilience assessment. Also in most of the planning frameworks described in section 3.1, one of the most important initial steps to formulate a climate resilience plan, is to create an 'inventory' of the vulnerabilities of the community in question. There has not been any standardize approach to conduct such analysis. A variety of frameworks/tools/methods have been applied in different contexts like disaster rash reduction, climate change, food security etc. Climate vulnerability assessment in urban areas have been evolving since late 2000[36], but still no agreed-upon standard method has been developed[37]. There has been attempts to develop guided methods (for example, a framework/workbook developed by the climate alliance[38]). But these are mostly broad guidelines which does not include the operational modeling suggestions to conduct the assessment through any scientific method. Tyler and Reed (2011)[39], described the vulnerability assessment process of the ten cities in Thailand, India, Indonesia and Vietnam, where the CRF (figure 3.1) was applied. But these are

[36] Tyler, S., Reed, S.O. (2011). *Results of resilience planning.* In M. Moench, S. Tyler, & J. Lage (Eds*.), Catalyzing urban climate resilience: Applying resilience concepts to planning practice in the ACCCRN program 2009–2011* (pp. 239–270). Boulder, CO: ISET.
[37] Brenkert, A. L., & Malone, E. L. (2005). *Modeling vulnerability and resilience to climate change: a case study of India and Indian states*. Climatic Change, 72(1), 57-102.
[38] Resilience Alliance. (2007*). Assessing resilience in socialecological systems: A workbook for scientists. Resilience Alliance*. Version 1.1. Draft for testing and evaluation. Available at: http://library.uniteddiversity.coop/Transition_Relocalisation_Resilience/resilience_workbook_for_scientists.pdf
[39] Tyler, S., Reed, S.O. (2011). Results of resilience planning. In M. Moench, S. Tyler, & J. Lage (Eds.), Catalyzing urban climate resilience: Applying resilience concepts to planning practice in the ACCCRN program 2009–2011 (pp. 239–270). Boulder, CO: ISET.

very short conceptual descriptions and the socioeconomic and climatic scenarios of these cities and countries are significantly different than the Midwest, rendering these methods potential unsuitable. There has been other methods developed to conduct vulnerability assessment focusing on specific natural/man-made disasters/hazards (for example, coastal storm risk assessment by USACE[40]). But specific hazard focused methods are not suitable for the present purpose as well. All the members of the Second Nature's climate commitment are still in the process of structuring the method for conducting this assessment and in continuous discussion about it. This section looks into the available scientific literature pool to investigate if any such process has been proposed or tested, which might help building an assessment process for UIUC campus.

3.2.1. The Vulnerability-Resilience Indicator Prototype (VRIP) model:

This is a vulnerability-resilience assessment model developed by Moss, et. al. (2001) and applied to assess the vulnerability-resilience of different countries on the world[41] and later adopted to assess vulnerability-resilience of the states in India[42]. This model defines *vulnerability* as, "[t]he *sensitivity* of system or process to climate change (the degree to which outputs or attributes change in response to changes in climate inputs) and the *adaptability* of that system (the extent to which changes are possible to take advantage of the new conditions)"[43]. Table 3.2.1 shows the sensitivity sectors and adaptability sectors. Each sector is composed of one to three proxies which are determined based on data availability and scenario specific. Though it has been recommended to determine these proxies subject to more research, Brenkert et. al. [26] applied the same proxies in case of India. This applicability, arguably, shows the versatility of the model.

[40] [40] USACE. (2015). *North Atlantic Comprehensive Study: Resilient Adaptation to Increasing Risk.* Main Report. Available at http://www.nad.usace.army.mil/Portals/40/docs/NACCS/NACCS_main_report.pdf

[41] Moss, R. H., Brenkert, A. L., & Malone, E. L. (2001). *Vulnerability to climate change: a quantitative approach*. Pacific Northwest National Laboratory (PNNL-SA-33642). Prepared for the US Department of Energy, 155-167. Available at http://www.globalchange.umd.edu/data/publications/Vulnerability_to_Climate_Change.PDF

[42] Brenkert, A. L., & Malone, E. L. (2005). *Modeling vulnerability and resilience to climate change: a case study of India and Indian states*. Climatic Change, 72(1), 57-102.

[43] Moss, R. H., Brenkert, A. L., & Malone, E. L. (2001). *Vulnerability to climate change: a quantitative approach*. Pacific Northwest National Laboratory (PNNL-SA-33642). Prepared for the US Department of Energy, 155-167. Available at http://www.globalchange.umd.edu/data/publications/Vulnerability_to_Climate_Change.PDF

The difference between the aggregated sensitivity score (the negative value) and the adaptive capability score (the positive value) is the vulnerability-resilience indicator (VRI). A positive value of the indicator expresses resilience and a negative value expresses vulnerability. A decomposition of the score can easily be done and interpreted as the contributing factors of the derived result of the indicator. The functional relationship is shown in figure 3.5.

Another positive aspect of this model is that it can be analyzed through a Monte-Carlo analysis to assess the uncertainties over time and due to change in the proxies. It also helps identifying 'dominant or leading' proxies over time. Proxies with the highest explanatory power (correlation between sampled proxies and the VRI) are determined as the leading proxies.

Table 3.2.1: Indicators, sectors, and proxies used in VRIP model Source: Moss, et. al (2001)

Sectors	**Proxy variables**	**Proxy for**	**Functional relationship**
Settlement/ infrastructure sensitivity	Population at flood risk from sea level rise	Potential extent of disruptions from sea level rise	Sensitivity ↑ as population at risk ↑
	Population without access to clean water/sanitation	Access of population to basic services to buffer against climate variability and change	Sensitivity ↑ as population with no access ↑
Food security	Cereals production/area	Degree of modernization in the agriculture sector; access of farmers to inputs to buffer against climate variability and change	Sensitivity ↓ as production ↑
	Animal protein consumption/capita	Access of a population to markets and other mechanisms (e.g., consumption shift) for compensating for shortfalls in production	Sensitivity ↓ as consumption ↑
Ecosystem sensitivity	% Land managed	Degree of human intrusion into the natural landscape and land fragmentation	Sensitivity ↑ as % land managed ↑
	Fertilizer use	Nitrogen/phosphorus	60-100 kg/ha is optimal. X< 60 kg/ha, sensitivity ↑ due to nutrient deficits and potential cultivation of

		loading of ecosystems and stresses from pollution	adjacent ecosystems. X >100 kg/ha (capped at 500 kg/ha), sensitivity ↑ due to increasing runoff
Human health sensitivity	Completed fertility Life expectancy	Composite of conditions that affect human health including nutrition, exposure to disease risks, and access to health services	Sensitivity ↓ as fertility ↓ Sensitivity ↓ as life expectancy ↑
Water resource sensitivity	Renewable supply and inflow Water use	Supply of water from internal renewable resources and inflow from rivers Withdrawals to meet current or projected needs	Sensitivity calculated using ratio of available water used: Sensitivity ↑ as % water used ↑
Economic capacity	GDP(market)/capita Gini index	Distribution of access to markets, technology, and other resources useful for adaptation	Coping-adaptive capacity ↑ as GDP per capita ↑ At present Gini held constant
Human and civic resources	Dependency ratio Literacy	Social and economic resources available for adaptation after meeting other present needs Human capital and adaptability of labor force	Coping-adaptive capacity ↓ as dependency ↑ Coping-adaptive capacity ↑ as literacy ↑
Environmental capacity	Population density SO_2/area % Land unmanaged	Population pressure and stresses on ecosystems Air quality and other stresses on ecosystems Landscape fragmentation and ease of ecosystem migration	Coping-adaptive capacity ↓ as population density ↑ Coping-adaptive capacity ↓ as SO_2 ↑ Coping-adaptive capacity ↑ as % unmanaged land ↑

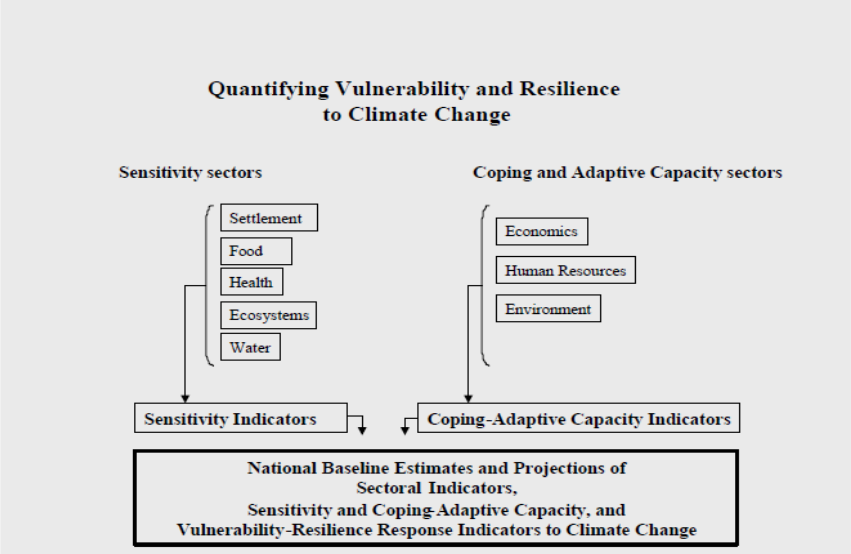

Figure 3.5: Functional relationship among the proxies and variables (Moss, et.al. (2001))

3.2.2. Campus Resiliency Index (CRI), California Polytechnic State University

This is an index calculated based on the planning framework proposed by the Rockefeller Foundation/ARUP (Figure 3.3). All the 52 indicators under the 12 categories in four sections were given a performance score based on their status in the California Polytechnic State University campus environment. This was a project done by three students for a course-work and has not been published. The process is under review currently to improve the scoring system. The results of this analysis have been cited in the Annual Report (2016) of the National Resilience Initiative by the American Institute of Architects briefly[44]. This can be a streamlined process to conduct the vulnerability assessment given there will be a scientific process published. The results of the analysis are shown in figure 3.6:

[44] AIA. (2016). *Forging Connections.* Annual Report, National Resilience Initiative, The American Institute of Architects. Architects Foundation. Available at http://aiad8.prod.acquia-sites.com/sites/default/files/2017-05/NRI%20Annual%20Report%20FINAL%205-3-17%20%281%29_1.pdf

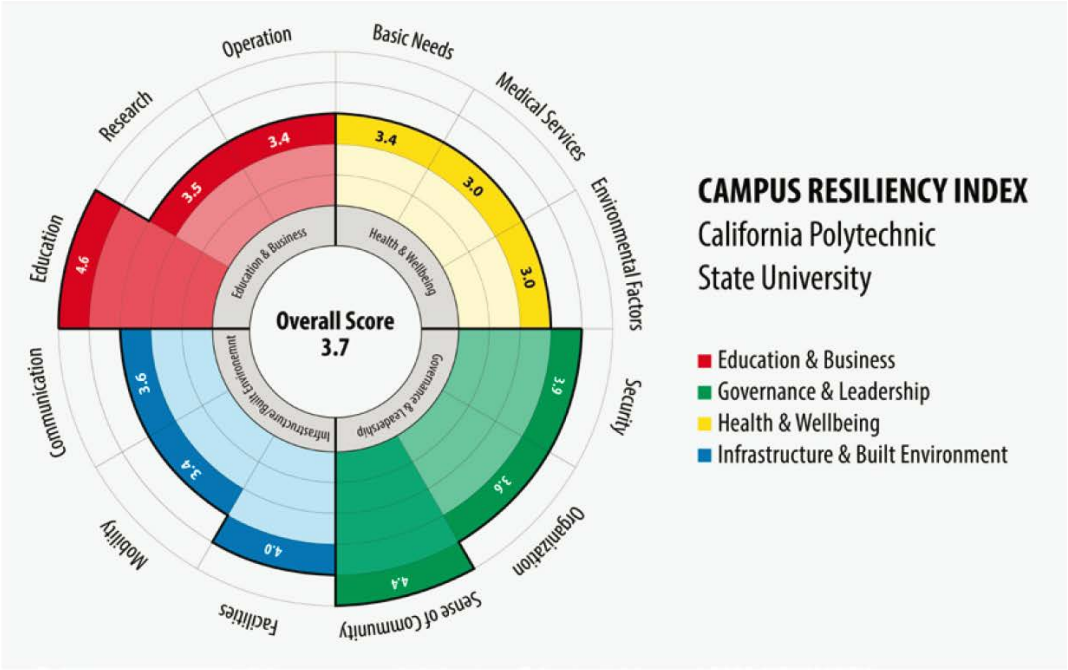

Figure 3.6: Campus Resiliency Index (CaRI)[28]

State of affairs in Champaign-Urbana:

The Institute for Sustainability, Energy, And Environment (ISEE) at the University of Illinois at Urbana-Champaign (UIUC), in coordination with UIUC Facilities and Services, has created a joint task force comprised of eleven members from the campus community as a requirement of the resilience commitment (the profile of the members is attached in Appendix A). The joint task force has scheduled regular meetings to assess and plan to achieve the goals of the resilience commitment.

The members agreed that the first step is to conduct an investigation on the status of resilience related planning and activities being conducted by different agencies in the community. This chapter highlights the completed and ongoing planning efforts by various organizations in the Champaign-Urbana community. Information on this were collected through online searches and literature review along with discussion with the task group members, as they are representative of a diverse interest in the community and also represent a wide range of institutions which have been working in climate change, sustainable practices and climate resilience planning of the Champaign-Urbana community. The following section describes the information provided by the task group members during the first task force meeting on May 7, 2017.

- **Excerpt from discussion during meeting:**

  Date: April 7, 2017, presided by Dr. Madhu Khanna.

  - Dr. Jim Angel (State Climatologist) talked about the climate change impacts in Champaign County. He discussed about increase in precipitation and an increase in heavy rain events in the Illinois State and Champaign County. This leads to increased river/urban flooding events and huge financial losses. Cities have made progress to increase drainage capacities, but it is still an issue. Backed up sewer water poses a public health risk and such events create the harshest impact on low-income communities. There are also mental health

issues which arise from stress due to financial loss from such events, which are not discussed usually.

Temperature is not the biggest concern presently but there are notable changes. Winters have been milder which has both pros and cons. One of the concerns with milder, shorter winters is the impact on trees due to early planting season. By midcentury, temperature will become a major concern. Extreme events like tornados are difficult to analyze and model due to their very localized nature and the lack of proper data. A trend of big increase is seen in the numbers of weaker tornado events, but not much change in the numbers of strong tornado events. Tornado season is considered now as the whole year.

- Molly Woloszyn (UI Extension Climate Specialist) talked about one of the concerns due to shorter winters is the lack of preparation among the students to withstand sudden harsh winter days/season. So, communicating about the nature of Midwest winters might be necessary. She mentioned that to handle extreme weather events during winter, city governments do not require permanent staff increases. Tools (like snowplow trucks) are not dedicated and work trucks are converted to snowplows for the winter, and extreme events are handled the existing staff pool working overtime. Several members pointed out the issue arose during Winter 2014 when melting salts became unavailable throughout the whole area. She also mentioned City's efforts to develop retention areas (like the Boneyard Creek) which also caters to lots of other issues besides improving storm water drainage.
- Marilyn Ruiz (Clinical Associate Professor, Pathobiology and Director, GISSA - the Lab for Geographic Information Science and Spatial Epidemiology) talked about public health issues like vector borne diseases are on the rise (e.g. ticks, mosquito borne diseases, etc.). She mentioned that in China, community based action and campaigns worked to combat such disease and such efforts should be useful here as well to improve these conditions at a local scale.
- Holly Rosencranz (Faculty, College of Medicine, UIUC) talked about climate

justice issues. For example, working class people suffer from heat exhaustion and heat stroke due to their long working hours and physical nature of work. Ground level ozone and heat can lead to cardiovascular diseases. An increase in pollen and related allergies are also on the rise.

- Scott Tess (Environmental Sustainability Manager, City of Urbana) mentioned Urbana has a program to reimburse cost to the homeowners who install green infrastructure, but the program is not used as expected. Perhaps more communication is necessary or the City can use the fund themselves to install green infrastructure citywide.
- Rita Morocoima-Black (Planning and Development Director, Champaign County Regional Planning Commission) talked about the Hazard Mitigation Plan, which was updated in 2015, and RPC is currently attempting to acquire funding to prepare a completely new plan. She also talked about the difficulty to implement these plans. She mentioned two more plans which has been prepared by the RPC (the Long Range Transportation Plan (LRTP): Sustainable Choices 2040, and the Regional Water Supply Framework).

- **Climate change impact:**

  Projections agree that temperature will rise by 3.5 degrees to 9 degrees Fahrenheit in the state of Illinois by the end of the century with the largest increase in summer[45]. Annual precipitation may increase by 3-6% by the end of this century with the greatest increase in winter. More winter precipitation will fall as rain rather than snow in the winter months. Much of this precipitation will occur as extreme weather events. But this does not necessarily mean there will be no drought. There will be longer periods without rain which may lead to water stress in the region[46]. There is a possibility of increased freeze-thaw events during early fall and late spring, which may lead to increased possibility of spalling, cracking and potholes in concrete roads and structures.

[45] Woloszyn, M. (2014). *Local Climate Change Impacts for Central Illinois.* Urban Sustainability Advisory Committee Midwestern Regional Climate Center & Illinois-Indiana Sea Grant. Available at https://www2.city.urbana.il.us/_Boards_-_Commissions/Sustainability_Advisory_Commission/2014/02-11-14/local-climate-change-impacts-central-illinois.pdf

[46] ibid

Predicted impacts include, but are not limited to[47]:

- Public health impact due to more heat waves, increased ozone pollution, urban flooding, rain on frozen ground or snow, and more non-point pollution
- Infrastructure and services disruption (e.g. less road salting during winter rain events, increased risk of falling trees and branches due to heavier rainfall, increased chances of flooding, sewer overflow, increased chance of winter power outages, higher energy demand in summer)
- Ecological impacts like negative impact on native species, plants, and entire ecosystem due to shifting of seasons, shifting of plant hardiness zone, etc.

A state-level public health impact assessment conducted in 2016[48] identified major climate change impacts, associated health impacts, and the people most affected from those. The following table summarizes the findings (adopted from the study)[49].

Table 4.1.1: Climate change impacts and associated health issues (from BRACE-Illinois, 2016)

Climate Change Impacts	Health Impacts	Most Affected People
Extreme Rainfall and Floods	· Property damage, loss of home and livelihood, population displacement	· Residents in flood-prone areas
	· Death from drowning	
	· Injuries	· Elderly
	· Damage to drinking water and wastewater systems resulting in worsening quality of drinking water and disruption to agriculture	· Children
	· Water- and food-borne diseases from sewage overflow	· Low-income communities
Extreme Heat	· Heat-related illnesses such as heat cramps, heat rash, heat exhaustion, and heat stroke	· Elderly
	· Dehydration	· Children
	· Death	· Low-income communities

[47] ibid
[48] BRACE-Illinois. (2016). *Climate and health in Illinois.* Prepared for the Illinois Department of Public Health (IDPH) by the Building Resilience against Climate Effects in Illinois (BRACE-Illinois) project of the University of Illinois at Chicago School of Public Health, Division of Environmental and Occupational Health Sciences. Available at https://ipha.com/content/uploads/Climate%20and%20Health%20in%20Illinois.pdf.
[49] ibid

	· People with heart conditions are more likely to have heart attacks	· People who live in places with more concrete and asphalt
		· People who work outside, such as farmworkers
		· People who are active outside
		· People with breathing diseases
		· Physically and mentally disabled people
		· People without access to or can't afford air conditioning
Increased Temperatures and Rainfall	· Increased number and range of diseases spread by ticks and mosquitoes, such as West Nile virus and Lyme disease	· Elderly
	· Increased and worsening breathing diseases caused by ozone pollution	· Children
	· Increased and worsening allergies caused by pollen	· People who work outside such as farmworkers
		· People who are active outside
		· People who live near wooded areas
		· People with allergies
		· People with asthma and other respiratory health conditions
Poor Air Quality/Air Pollutions	· Increased and worsening asthma, allergies, chronic obstructive pulmonary disease (COPD), and other breathing diseases	· Elderly
		· Children
		· Low-income communities
		· Communities of color
		· People with breathing diseases
		· People who are active outside

All Impacts	· Mental health disorders (e.g., depression, anxiety, Post-Traumatic Stress Disorder, and other conditions caused by traumatic events, displacement, and loss of home, lives, and livelihood)	· Low-income communities
		· Communities of color
		· All populations

Existing plans developed by Champaign-Urbana authorities:

- Champaign County Multi-Jurisdictional Hazard Mitigation Plan (2015 update)[50][HMP]:
  This plan, produced by the Champaign County Regional Planning Commission (CCRPC), identified and prioritized community policies, actions and tools to implement to reduce potential risk and associated losses from selected natural and man-made hazards. It describes profiles of several selected 'natural and technical disasters, associated risk assessments, mitigation goals, mitigation action implementation schedule, and schedule for evaluating and updating the plan at a regular interval.
- A Regional Water Supply Framework For Champaign County And East-Central Illinois[51] (WSF):
  This report was produced in 2016 by the CCRPC to assess the current status of the water supply in terms of quantity and quality in east-central Illinois (Champaign County). The main objective of the study was to create a regional water supply framework to ensure continued water supply in the region in desired quantity and quality. The report listed preferred strategies to- "i) support the advancement of knowledge regarding groundwater resources, ii) help achieve sustainable long term use of the Mahomet Aquifer, iii) to help prevent groundwater pollution, iv) encourage regional cooperation to protect Mahomet Aquifer, v) encourage regional cooperation to protect ground water, vi) further public engagement in water issues."

[50] Regional Planning Commission. (2015). *Champaign County Multi-Jurisdictional Hazard Mitigation Plan: 2015 Update.* Available at: https://www.urbanaillinois.us/sites/default/files/attachments/Hazard%20Mitigation%20Plan%20-%20Final%20Draft%20August%202015.pdf
[51] Regional Planning Commission. (2016). *A Regional Water Supply Framework for Champaign County and East-Central Illinois.* Available at https://ccrpc.org/wp-content/uploads/2016/11/Regional-Water-Supply-Framework_2016_FINAL_1108.pdf

- Campus Emergency Operations Plan- 2016, UIUC (CEOP)[52]:

  This document outlines the plan of the UIUC campus to respond and recover from natural and/or man-made disasters that may affect the campus. This document identified eleven potential natural disasters that may affect the campus:

  - Drought
  - Extreme heat
  - Earthquakes
  - Floods: flash, rain, river, and urban
  - Landslide
  - Lightning
  - Public health epidemics
  - Severe winds
  - Tornados
  - Wildfire: brush, grassland, and woodland
  - Winter storms (severe): blizzard, extreme cold, ice storm, heavy snow

  The plan then describes detailed protocols and procedures for overall emergency management operation in an event of a disaster. This includes structure, responsibility and authority of the emergency management body, succession plan, list of responsibilities of different bodies in the campus, among other aspects of the four-step emergency operations: 1) mitigation, 2) Preparedness, 3) Response, and iv) Recovery.

In summary, the ISEE at the UIUC is on the path to accomplish the requirements of the resilience commitment objectives set by the Second Nature. Initial steps are completed with the formation of the joint task force with the members of the community and coordination meetings. Impact of climate change on the community and the state of Illinois have already been identified. Different authorities are involved in planning for climate resilience and there are several plans formulated to address different issues related to resilience (eg. Hazard mitigation, water supply framework, emergency response etc.). But, as it was discussed by the members of the joint task force, the community's efforts are disconnected and there is a large gap in knowledge and skill sharing between the so-called "town and gown" which will be one of the major focuses of the task force to bridge. According to several task force

[52] University of Illinois Police Department. (2016). *Campus Emergency Operations Plan- 2016.* Available at: http://police.illinois.edu/dpsapp/wp-content/uploads/2016/12/campus-emergency-operations-plan-2016.pdf

members, another major issue is the lack of funding to implement the plans which have already been formulated.

At this point, with the understanding of the requirements of the resilience commitment, knowledge of existing literature on resilience farmeworks and vulnerability assessment methodologies and taking stock of overall current situation of the campus-community's effort to address resilience, the task force is planning to go forward with the next steps of the endeavor. The next section highlights these next steps.

Chapter 5

Future steps and concluding remarks:

According to the plan put forward by the task force and reporting requirements by the Second Nature, the immediate to-do for the Resilience Commitment Task Force can be listed as follows:

1) To identify and invite additional members to join the task force based on recommendation by the exiting members and gap in representation and expertise. *[This is already in process].*
2) To adopt a resilience planning framework based on the existing examples available [described in chapter 3 in details with examples]. It is advisable to adopt (with modification to suit the needs of Champaign-Urbana) the framework developed by the Rockefeller foundation and ARUP (see section 3.1.3). The next step of this study can be commissioned to study this framework in details and adapt it to specific needs of the Champaign-Urbana community.
3) The next immediate reporting requirement from the Second Nature is to conduct the Resilience Assessment (by February 2018). This study should also commissioned immediately. Available resilience/vulnerability assessment methods are described in section 3.2. Though there has not been much work done in this area, the existing methods can be adapted and modified. The method developed by the California Polytechnic state University (section 3.2.2) is based on the framework developed by the Rockefeller Foundation /ARUP. Though it has not been published yet, it can be a good method to adopt if the framework is decided based upon this.

Campus communities in the US are becoming one of the major stakeholders to battle the impacts of climate change and are uniquely positioned to further the agenda nation and worldwide. Hundreds of educational organizations in the US, including U of I, have achieved commendable progress in planning for sustainable practices and implementing those plans. But 'resilience/adaptation' is rather an emerging concept which is gaining more and more importance in public policy. Much like advancement in the sustainability agenda, academic

institutions in the US have taken up the mantle to further resilience. One of the major initiatives in this arena is the “resilience commitment” by the Second Nature and U of I, along with hundred other fellow organizations can foster the gap between the academia and community to foster the resilience agenda. As found out during the task force meeting, two of the major issues that hamper a coordinated approach is the gap between “town-gown” relationship and overlap in efforts, along with lack of implementation of the plans. This task force can be a major tool to bridge that gap and produce important knowledge in this regard. This will also potentially pave a way to pool resources which may make it easier to fund the implementation of several plans. U of I can take a major role in this nationwide campaign and emerge as a national leader in resilience planning.

Appendix A

Profile of task force members

Member	Bio	Contact	Photo
Dr. Jim Angel, State Climatologist	Dr. Jim Angel has been the Illinois State Climatologist since 1997 and began work at the Illinois State Water Survey in 1984. He has a broad interest in all things related to weather and climate, including droughts, floods, winter storms, heat waves, tornadoes, and long-term climate change (past, present, and future). He has worked on a number of research projects looking at drought, extreme rainfall events, Great Lakes storms, 19th and 20th century climate change, potential future climate change, as well as the impacts of weather and climate extremes. Besides research, he works with a wide range of users and stakeholders, including students, teachers, homeowners, engineers, other scientists, farmers, as well as federal, state, and local officials on issues related to climate. He maintains this website, a blog, and twitter feed for addressing a wide variety of climate topics as they pertain to Illinois.	jimangel@illinois.edu	
Scott Tess, City of Urbana, Environmental Sustainability Manager		srtess@urbanaillinois.us	

Molly Woloszyn, UI Extension Climate Specialist	Molly Woloszyn is Illinois-Indiana Sea Grant's climate specialist. She has a joint position with the Illinois State Water Survey and IISG, which offers the opportunity to pair Sea Grant extension expertise with the survey's climate science. Molly is located at the Midwest Regional Climate Center in Champaign, IL. Molly received a B.S. from Northern Illinois University meteorology program. While she was a student, Molly participated in an internship with the water survey during which she essentially served as a service climatologist for a summer. She went on to earn a Master's degree at Colorado State University and has been teaching at community colleges for the last few years.	mollyw@illinois.edu	
Rita Morocoima-Black, Champaign County Regional Planning Commission		rmorocoi@co.champaign.il.us	

Marilyn O'Hara Ruiz, Clinical Associate Professor, Pathobiology and Director, GISSA - the Lab for Geographic Information Science and Spatial Epidemiology	Research Interests: • How do processes measured at different temporal and spatial scale affect the behavior of ecological systems? • The spatial and contextual aspects of health and illness from a One Health perspective: combining human, animal, and ecosystem health. • Development of spatial visualizations, models and methods to develop risk maps and early warning systems for vector-borne disease transmission. • The effect of urban and regional policy decisions and structures on patterns of the built environment, vegetation and habitat potential and their relationship with public health outcomes.	moruiz@illinois.edu	
Madhu Khanna, iSEE, ABE faculty	Professor Khanna has worked on diverse topics ranging from technology adoption and agro-environmental policy analysis, voluntary approaches to environmental protection and the land use, market and greenhouse gas implications of biofuels. Her work on technology adoption seeks to provide a rationale for the often-observed low rates of adoption of efficiency-enhancing technologies and shows the importance of considering heterogeneous producer characteristics, risks, uncertainty and market failures that distort prices while analyzing the incentives to adopt these technologies. She also examines the design of conservation payments to induce the adoption of improved land management practices to reduce non-point pollution from agriculture and enhance soil carbon sequestration. Her research also examines the effectiveness of environmental information disclosure policies and voluntary pollution control programs in achieving environmental protection.	khanna1@illinois.edu	

Morgan Johnston, F&S Sustainability	Morgan B. Johnston is an Associate Director of Facilities & Services (F&S) and the Director of Sustainability at F&S. In 2008, she took on the role of Transportation Demand Management (TDM) Coordinator, an inherently sustainability-related effort, reducing single-occupancy vehicles on campus. A year later she got her first taste of overall campus sustainability efforts when she was asked to contribute to conversations about what transportation goals should be included in the 2010 Illinois Climate Action Plan (iCAP). After that document was signed, Morgan began implementing the F&S-related campus sustainability solutions outlined therein.Among the solutions she implemented, Morgan is most proud of the Campus Bike Center. Beginning as a collaboration between the University of Illinois and The Bike Project of Urbana-Champaign to increase ridership, the Campus Bike Center is now a multifunctional educational resource for those who want to learn about the bicycling world in Champaign-Urbana and how to perform basic bike maintenance.Today, Morgan serves as the primary liaison between iSEE and F&S.	mbjohnst@illinois.edu	
Lacey Rains, City of Champaign, Sustainability Planner	Areas of Focus: comprehensive planning, sustainability planning, Historic Preservation Commission, census, neighborhood wellness	lacey.rains@champaignil.gov	

Paolo Gardoni, CEE faculty, UIUC	Paolo Gardoni is a Professor and Excellence Faculty Scholar in the Department of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign. He is the Director of the MAE Center which focuses on the creating of a Multi-hazard Approach to Engineering, and the Associate Director of the NIST-funded Center of Excellence for Risk-based Community Resilience Planning. Dr. Gardoni is the founder and Editor-in-Chief of the international journal Sustainable and Resilient Infrastructure. He is a member of a number of national and international committees and associations that focus on risk and reliability analysis, specifically, he is a member of the Board of Directors of the International Civil Engineering Risk and Reliability Association (CERRA). Dr. Gardoni's research interests include sustainable and resilient infrastructure; reliability, risk and life cycle analysis; decision making under uncertainty; earthquake engineering; performance assessment of deteriorating systems; ethical, social, and legal dimensions of risk; policies for natural hazard mitigation and disaster recovery; and engineering ethics. He is the author of over 100 refereed journal papers and 3 edited volumes. Most of the publications are the result of research activities conducted in 31 funded research projects for over $26 million in research funding from multiple national and international agencies including the National Science Foundation (NSF), the Qatar National Research Funds (QNRF), the National Institute of Standards and Technology (NIST), the Nuclear Regulatory Commission (NRC) and the Army Corp of Engineers.	gardoni@illinois.edu	

Holly Rosencranz, College of Medicine, faculty	Dr. Holly Rosencranz is an internist in Urbana, Illinois and is affiliated with multiple hospitals in the area, including Carle Foundation Hospital and Provena Covenant Medical Center. She received her medical degree from University of Illinois College of Medicine and has been in practice for more than 20 years. She is one of 49 doctors at Carle Foundation Hospital and one of 19 at Provena Covenant Medical Center who specialize in Internal Medicine. She is also a Clinical Assistant Professor at the College of Medicine at U of I	harosen@illinois.edu	
Warren Lavey	Warren Lavey is Adjunct Assistant Professor at the Dept. of Natural Resources and Environmental Sciences, U of I. He also holds professional positions at numerous organizations like Senior Fellow, Environmental Law and Policy Center (Chicago) Senior Regulatory Counsel, American Clean Skies Foundation (Washington, DC) Retired Partner, Skadden, Arps, Slate, Meagher & Flom LLP (global law firm) External Advisory Committee, Illinois Sustainable Technologies Center External Advisory Committee, University of Illinois at Chicago School of Public Health.	lavey@illinois.edu